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(19)

(54) IMPROVEMENTS IN OR RELATING TO AN APPARATUS SUITABLE FOR USE IN, AND A METHOD OF, SPRAY-DRYING A LIQUID

(71) We, STORK AMSTERDAM B.V. a Netherlands limited liability company of 198, Sportlaan, Amstelveen, the Netherlands, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an apparatus suitable for use in, and a method of, spray-drying a liquid. The present invention relates generally to an apparatus for spray-drying a liquid which comprises a substantially cylindrical column having at its lower end a conically tapering bottom with a discharge opening for powder particles and at its upper end a cover with a central inlet for the liquid to be dried, an inlet for drying gas debouching into the column and an outlet for exhaust gas. Such an apparatus is known in many versions as a spray-dryer for the production of dried milk (also called milk powder).

Such an apparatus often intentionally issues powder particles having a certain degree of humidity which is for instance of importance when a second drying is performed. Under such circumstances the particles are apt to stick to the inner wall of the conical bottom, or in other words: "they cake on the cone". Efforts have been made to alleviate this difficulty by imparting a rotary motion to the drying gas by using a tangential supply of the gas. This gas is thereupon exhausted in the central part of the cone. This process results, however, into the disadvantage that an obstacle is mounted in the centre of the lower part of the column, which gives rise to disturbance of the progress of flow.

An object of the present invention is to provide an apparatus suitable for use in, and a method of, spray-drying a liquid which overcomes or at least mitigates the disadvantageous phenomenon of caking on the conical bottom.

According to a first aspect of the present invention there is provided an apparatus suitable for use in spray-drying a liquid, which apparatus comprises a substantially cylindrical column, the column having at the lower end thereof a conically tapering bottom with a discharge opening for powder particles and having at the upper end thereof a cover with a central spray inlet for liquid to be dried, inlet means, for drying gas, opening into an upper zone of the column and comprising a ring of openings such that the drying gas flows, in use, concentrically of the central inlet, an outlet, for exhaust gas, situated in the upper zone of the column and a plurality of substantially tangentially directed flushing gas inlets situated at the circumference of a wall of the conical bottom for flushing gas under pressure such that, in use, a sweeping gas-flow is created by the flushing gas along the inner wall of the conical bottom.

According to a second aspect of the present invention there is provided a method of spray-drying a liquid, which method comprises passing a liquid to be spray-dried through a central spray inlet of a cover situated at an upper end of a substantially cylindrical column into the column, which column has at the lower end thereof a conically tapering bottom having a discharge opening for powder particles formed from the liquid, passing a drying gas through inlet means opening into an upper zone of the column and comprising a ring of openings such that the drying gas flows concentrically of the central inlet and passing a flushing gas under pressure into the column *via* a plurality of substantially tangentially directed flushing gas inlets situated at the circumference of a wall of the conical bottom such that the

flushing gas flows along the inner wall of the conical bottom, gases exhausting from the column *via* an outlet provided in the upper zone of the column.

The present invention further relates to material whenever spray-dried using the apparatus of the first aspect and/or using the method of the second aspect.

In operation of the apparatus and method, a central area is normally obtained within the column in which the drying process is performed, while the flushing gas normally describes a substantially helical path around this central are and prevents or reduces the particles from caking, that is sticking.

An advantageous flow pattern can be obtained within the column when the flushing gas inlets are directed along the conical wall and are provided at a level which is situated at a distance of at least 1/5 of the height of the conical bottom under the plane at which the cone of the conical bottom begins.

Advantageously, means are provided for supplying the flushing gas at a velocity of at least 10 m/sec.

Preferably, the flushing gas is preconditioned such that stickiness of the powder particles is reduced on contact of the powder particles with the flushing gas.

For example, it can be important in some applications to select the temperature of the flushing gas such that the powder particles do not tend to stick to each other. Sometimes this gas, such as air, should have a cooling effect, for example in the case of thermpolastic products, another time it should have a drying effect. A conditioning device for this gas is required generally.

For a better understanding of the present invention and to show how the same may be put into effect, reference will now be made, by way of example, to the accompanying drawing, in which:—

Figure 1 shows a vertical part-sectional view of an embodiment of an apparatus in accordance with the present invention and comprising a drying column having an inlet for flushing gas,

Figure 2 shows a part-sectional view of part of a first modified conical bottom for the apparatus of Figure 1, and

Figure 3 shows a part-sectional view of part of a second modified conical bottom for the apparatus of Figure 1.

As shown in Figure 1 of the drawing, the apparatus or device comprises a cylindrical column 1 having at its lower end a conically tapering bottom or cone 2. A discharge opening 3 is provided at the underside or base of the cone for discharging 5 for the liquid to be dried is situated at the upper side of the column 1. Inlet means 6 for the drying gas is constructed as a ring of downwardly directed openings situated around the inlet 5. As a result, the drying gas will flow concentrically around the central inlet 5. Tangentially directed openings 7 are provided in the wall of the cone 2 and are connected to a supply pipe 8 for flushing gas, for example air, which is supplied by a blower 9. An outlet 10 for the exhaust gas is situated in the vicinity of the cover 4. This outlet is connected to a cyclone 11 provided with a blower 12 for separating fine particles present in the exhaust gas.

The flow of the gases within the column 1 and the cone 2 is indicated in Figure 1 by arrows. The drying gas flows down as a substantially cylindrical curtain whilst simultaneously producing a drying effect on the atomized liquid particles from the central inlet 5. After having penetrated a certain depth into the cone 2, the cylindrical flow diverges, whilst simultaneously curving in an upward direction and escapes finally *via* the outlet 10 in the vicinity of the cover 4. The flushing gas enters at a rate faster than 10 m/sec at about halfway the height of the cone 2 and constitutes a turbulating path situated near the inner wall of the column and finally escapes also *via* the outlet 10.

Due to the supply of flushing gas, the powder particles will hardly or not at all touch the inner wall of the cone 2 and no cake will normally be produced on this wall. The outlet 3 for the powder remains open in this way and the apparatus can normally operate for a considerable time.

Figures 2 and 3 show preferred modifications of the openings 7 for the flushing gas. In the Figure 1 embodiment an annular duct 13 is connected to the supply pipe 8, the openings 7 being connected to the annular duct 13. In the Figure 2 modification the wall of the cone 2 has a cylindrical zone 14. An annular casing 15 is arranged around zone 14, and the tangentially directed openings 7 debouch into the cone in the zone. In the Figure 3 modification the wall of the cone 2 is interrupted to form thus the tangentially directed openings 7.

It should be noted that in all three embodiments the openings 7 are only at a single level. The invention encompasses, however, also an apparatus in which the openings 7 are provided at different levels in the cone 2. These openings are advantageously provided in an area of the conical wall which is at least situated at 1/5

entirely or partially dried powder. A cover 4 having the usual central inlet or atomizer of the height of the cone, underneath the widest part thereof.

It should be further noted that the conditioning of the flushing air notably temperature and moisture content, should advantageously be tuned in such a way to the properties of the powder particles that a cooling effect is produced when dealing with thermoplastics products or a drying effect when dealing with moist powder particles. It is further observed that the supply openings 7 do not need to lie accurately tangential, but that the openings should be directed along the inner wall. This is required so as to order to obtain an "air sweep" effect along the inner wall of the cone.

WHAT WE CLAIM IS:—

1. An apparatus suitable for use in spray-drying a liquid, which apparatus comprises a substantially cylindrical column, the column having at the lower end thereof a conically tapering bottom with a discharge opening for powder particles and having at the upper end thereof a cover with a central spray inlet for liquid to be dried, inlet means, for drying gas, opening into an upper zone of the column and comprising a ring of openings such that the drying gas flows, in use, concentrically of the central inlet, an outlet, for exhaust gas, situated in the upper zone of the column and a plurality of substantially tangentially directed flushing gas inlets situated at the circumference of a wall of the conical bottom for flushing gas under pressure such that, in use, a sweeping gas-flow is created by the flushing gas along the inner wall of the conical bottom.

2. An apparatus according to Claim 1, wherein the flushing gas inlets are provided at a level which is situated at a distance of at least 1/5 of the total height of the bottom under the plane at which the cone of the bottom begins.

3. An apparatus according to Claim 1 or 2, which comprises conditioning means for preconditioning the flushing gas such that, on contact of the flushing gas with the powder particles, stickiness of the powder particles is reduced.

4. An apparatus according to Claim 1, 2 or 3, which comprises means for supplying the flushing gas at a velocity of at least 10 m/sec.

5. An apparatus according to any one of the preceding claims, wherein the flushing gas inlets lie in a single plane.

6. A method of spray-drying a liquid, which method comprises passing a liquid to be spray-dried through a central spray inlet of a cover situated at an upper end of a substantially cylindrical column into the column, which column has at the lower end thereof a conically tapering bottom having a discharge opening for powder particles formed from the liquid, passing a drying gas through inlet means opening into an upper zone of the column and comprising a ring of openings such that the drying gas flows concentrically of the central inlet and passing a flushing gas under pressure into the column *via* a plurality of substantially tangentially directed flushing gas inlets situated at the circumference of a wall of the conical bottom such that the flushing gas flows along the inner wall of the conical bottom, gases exhausting from the column *via* an outlet provided in the upper zone of the column.

7. A method according to Claim 6, wherein the flushing gas inlets are provided at a level which is situated at a distance of at least 1/5 of the total height of the bottom under the plane at which the cone of the bottom begins.

8. A method according to Claim 6 or 7, wherein the flushing gas is preconditioned such that stickiness of the powder particles is reduced on contact of the powder particles with the flushing gas.

9. A method according to Claim 6, 7 or 8, wherein the feed velocity of the flushing gas is at least 10 m/sec.

10. An apparatus suitable for use in spray-drying a liquid, substantially as hereinbefore described with reference to, and as shown in, Figure 1 of the accompanying drawing.

11. An apparatus suitable for use in spray-drying a liquid, substantially as hereinbefore described with reference to, and as shown in, Figure 1 modified by Figure 2 of the accompanying drawing.

12. An apparatus suitable for use in spray-drying a liquid, substantially as hereinbefore described with reference to, and as shown in, Figure 1 modified by Figure 3 of the accompanying drawing.

13. A method of spray-drying a liquid, substantially as hereinbefore described with reference to Figure 1 of the accompanying drawing.

14. A method of spray-drying a liquid,

substantially as hereinbefore described with reference to Figure 1 modified by Figure 2 of the accompanying drawing.

15. A method of spray-drying a liquid, substantially as hereinbefore described with reference to Figure 1 modified by Figure 3 of the accompanying drawing.

16. Material whenever spray-dried using the apparatus of any one of Claims 1 to 5 and 10 to 12 and/or using the method of any one of Claims 6 to 9 and 13 to 15.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

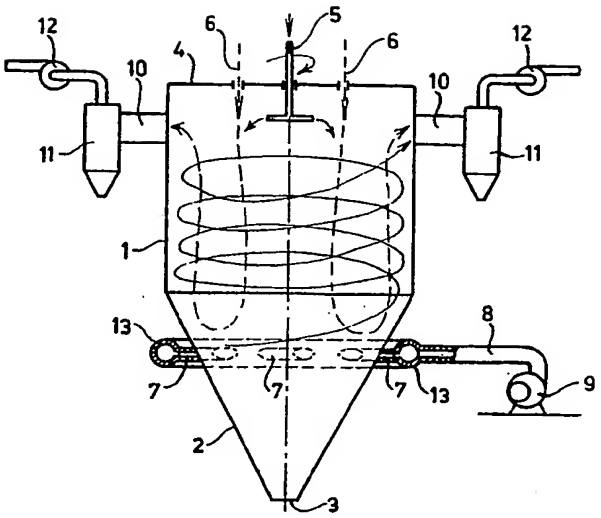

Fig. 1.

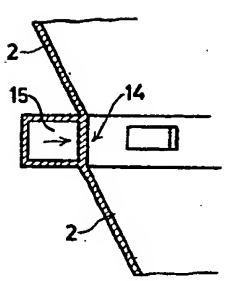

Fig. 2.

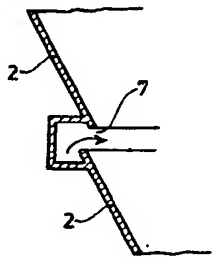

Fig. 3.